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ABSTRACT

Student responses to the Learning Environment Inventory were obtained from six physics classes, ten chemistry classes and ten biology classes in eight English-speaking schools in the Montreal Metropolitan area. A three-level, one-way multivariate analysis of covariance with the 15 Learning Environment Inventory Scales as dependent variables and teacher sex, class size, and class sex compositions as the covariates, was used to examine the relationship of the three courses to the social climate of learning. The analysis indicated that physics classes are perceived as relatively difficult, goal directed and as containing teacher favoritism, with little function, apathy, speed, or positive affect towards the environment. Biology classes were least like physics classes in these respects. (EB)

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STUDENT PERCEPTIONS OF THEIR SCIENCE CLASSES: CLASSROOM CLIMATE DIFFERENCES IN PHYSICS, CHEMISTRY AND BIOLOGY

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A recent study (Anderson, 1970) examined the premise that student perceptions of the interpersonal relationships and learning experiences in their classes were related to the nature of the subject being studied. Support was found for a number of course differences. Mathematics classes were characterized as containing more interpersonal friction among pupils, disorganization, informality, and subject difficulty, as compared to classes in science, the humanities, and languages. Differences between the humanities and the sciences took the form of higher scores for humanities classes on measures of Diversity, Cohesiveness, Goal Direction and Apathy with correspondingly lower scores on Formality, Speed, Satisfaction and Disorganization. In this overall analysis, physics, chemistry and biology classes were pooled.

One other study (Anderson, Walberg & Welch, 1969) considered two types of physics courses. Classes studying the Harvard Project Physics Course were viewed as less difficult, less goal directed and as containing a greater diversity of experiences

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than were classes using traditional course materials. The purpose of this study is to fill the gap between these two previous analyses by exploring the nature of classroom climate differences in physics, chemistry, and biology.

METHOD

Sample

Data were obtained during a one-month period in mid-winter, 1970, from eight English-speaking secondary schools in the Montreal Metropolitan area. The sample was stratified to represent four reasonably distinct geographic regions, and two schools were chosen from each region. Classes were sampled randomly within schools. The six physics classes were all taught by male teachers; whereas, chemistry was split into eight males and two females, and in biology there were six males and four females. The specific courses were most often of the so-called "traditional" variety though the sample includes several classes of Harvard Project Physics, BSCS biology, and CHEM-Study.

Pupils generally ranged from 15 to 17 years of age and had mean scores[2] on the Henmon-Nelson Test of Mental Abilities corresponding to the 43rd percentile of college-level students.

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[2]Based on a random sample of 103 pupils.

Instrument

The 15 scales of the Learning Environment Inventory describe the classroom climate as perceived by the pupils along 15 dimensions that reflect the relationship of the pupils to one another, to the organizational properties of the class, to class activities, and to the physical environment. The instrument is a slight modification of an earlier one of the same name (Anderson, 1970). In all, six of the original items were modified and a competitiveness scale was added. Each of the Learning Environment Inventory scales contains seven statements descriptive of typical high school classes (see Table 1).

The respondent expresses the extent of his agreement or disagreement with each item on a four-point scale. For each of the 15 dimensions, the mean response on the seven items is calculated and the mean of all student ratings in each class provides the estimate of the collective student perception of their classroom climate.

Statistical Analysis

A three-level, one-way multivariate analysis of covariance (Jones, 1966; Bock, 1966) with the 15 Learning Environment Inventory scales as dependent variables, and teacher sex, class size, and class sex composition as the covariates, was used to examine the relationship of the three courses to the social climate of learning.

A multivariate analysis is useful in problems such as this one as it enables not only tests for the contribution of each effect to each dependent variable, separately, but also the examination of overall concomitant effects on all variables considered simultaneously (see Jones, 1966 for a more complete discussion of the advantages of multivariate analysis of variance). Indeed, a multivariate test is essential in order to avoid the fallacy of obtaining statistical significance through repeated application of a univariate test to correlated variables.

The multivariate analysis first performs an F-test for equality of mean vectors. This is used to determine the probability of obtaining observed differences across all variables by chance alone. If the overall test implies that overall differences do exist, then these differences may be examined further in several ways. The individual contribution of each dependent variable to discrimination among levels of an effect may be tested as in a traditional analysis of variance with only one dependent variable. However, this method has the disadvantage of not incorporating concomitant effects among the battery of dependent variables. Another approach is to fit discriminant functions to the dependent variables in order to more adequately characterize differences among the levels of the factor. This approach fully utilizes the available data and provides for interactions among dependent variables.

In this analysis there were three major complicating factors -- teacher sex, class size and student sex. None of the physics teachers were female; and both class size and sex composition were related to the subject being studied. Physics classes had an average size of 14 with 22% of the pupils females. Chemistry classes contained 45% females and averaged 25 pupils, while in biology, 51% of the pupils were female and the average class size was 22. Thus, to control these variables a covariance analysis was used to statistically remove their effects from the 15 measures of classroom climate.

RESULTS

The results of the analysis of covariance are summarized in Table 2. The multivariate F-test equaled 2.7 (df = 30/12) and is statistically significant at the .04 level of confidence. Two discriminant functions accounted for 89% and 11% of the variance, respectively. Only the first function was statistically significant. Standardized discriminant function coefficients for this function are listed in Table 2. These indicate the deviation of each group mean on each scale from the means of the group of physics classes.

The first discriminant function is defined by the Learning Environment Inventory Scales with high discriminant loadings on the function. Thus, high scores on Difficulty (3.19), Favouritism (1.04) and Goal Direction (0.98) and low scores on Environment (-3.57),

Speed (-3.51), Friction (-2.51), Apathy (-2.34), and Formality (-1.15) define high (positive direction) scores on the discriminant function. The scores on this function are -12.5 for biology, -5.2 for chemistry and 0.0 for physics. Thus, physics classes are perceived as difficult, goal directed and as containing teacher favouritism, with little friction, apathy, formality, speed or positive affect towards the environment. Biology classes are at the other end of the discriminant function with chemistry somewhere in between.

DISCUSSION

The findings are generally as one would expect. Physics, a "hard" science, is at one extreme with the more humanistic, less mathematical subject, biology, at the other. Students perceive their biology classes, as compared to those in physics, as faster moving formal groups with more apathetic classmates, more interpersonal friction, and more pleasant environments. Furthermore, biology classes are perceived as less difficult and goal directed with less teacher favouritism than are physics classes. One would perhaps expect more perceived difficulty and goal direction in a subject which is taught sequentially with a mathematical foundation; however, there is no apparent reason for more teacher favouritism. On the basis of the findings one might speculate that there is more room for group discussion and interpersonal conflict in biology classes. This might also contribute

to the feeling of a lack of goal direction and too fast a pace to enable students to fully appreciate the subject under study. The lack of structure and goal direction might necessitate the teacher imposing more formal rules for classroom procedures than are needed in physics classes.

It should be noted that the discriminant function reflects general constellations of variables only and scores on some individual climate dimensions may appear to differ from the pattern. This occurs for Environment and Difficulty which have high discriminant loadings but contradictory patterns of group means (see Table 2). It is clear that these scales are being moderated or suppressed by the presence of other climate patterns simultaneously. In summary, physics, chemistry and biology classes appear to differ on several measures of student perceptions of their classes. Some of these differences undoubtedly result from the different student populations who elect to take these courses, and further analyses will be required in order to precisely determine the relationships between the nature of the subject studied and student perceptions of their classes. Additional research will attempt to look within the classes and examine the finestructure produced by particular laboratory groups, seating patterns, and sociometric relationships among pupils.

TABLE 1

Learning Environment Inventory Scales

Scales			Alpha [a] Reliabilities
1.	Cohesiveness	Members of the class are personal friends.	.69
2.	Diversity	The class divides its efforts among several purposes.	.53
3.	Formality	Students are asked to follow a complicated set of rules.	.76
4.	Speed	The class has difficulty keeping up with its assigned work.	.70
5.	Environment	The books and equipment students need or want are easily available to them in the classroom.	.56
6.	Friction	Certain students are considered uncooperative.	.72
7.	Goal Direction	The objectives of the class are specific.	.85
8.	Favoritism	Only the good students are given special projects.	.78
9.	Difficulty	Students are constantly challenged.	.64
10.	Apathy	Members of the class don't care what the class does.	.82

[a]Based on a sample of 1048 individuals. Sample intraclass correlations for the reliability of class means are shown in Anderson (1970) *b*.

TABLE 1

Learning Environment Inventory Scales (Cont'd)

Scales			Alpha [a] Reliabilities
11.	Democratic	Class decisions tend to be made by all the students.	.67
12.	Cliqueness	Certain students work only with their close friends.	.65
13.	Satisfaction	Students are well-satisfied with the work of the class.	.79
14.	Disorganization	The class is disorganized.	.82
15.	Competitiveness	Students compete to see who can do the best work.	.63

[a]Based on a sample of 1048 individuals. Sample intraclass correlations for the reliability of class means are shown in Anderson (1970) *b*.

TABLE 2

Summary of Significant Results

Scales	Least square estimates adjusted for covariates and compared to physics classes chemistry	biology	Standardized Discriminant Function Coefficients ($p < .01$)
Cohesiveness	-2.0	-1.2	-0.08
Diversity	-0.3	0.5	-0.24
Formality	2.9	3.9	-1.15
Speed	1.7	4.0	-3.51
Environment	-2.0	-0.5	-3.57
Friction	1.2	1.0	-2.51
Goal Direction	-0.6	-0.6	0.98
Favoritism	0.9	1.6	1.04
Cliqueness	0.7	0.0	0.50
Satisfaction	-1.1	-2.1	-0.34
Disorganization	-0.6	-0.4	0.45
Difficulty	0.0	0.0	3.19
Apathy	2.0	1.2	-2.34
Democratic	-0.6	-1.3	-0.94
Competitiveness	-0.7	-1.2	0.39

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